A Field Reconfigurable Manipulator for Rovers, Phase I

Completed Technology Project (2007 - 2007)

Project Introduction

Robots will be precursors to human exploration of the lunar surface. They will be expected to prepare the lunar surface for human habitation as well as conduct scientific investigations. As humans arrive the robots should be able to shift to providing direct assistance to human exploration activities. Such tasks require a new generation of robotic vehicles -- a generation that has flexible, dexterous manipulation capabilities and adjustable software controllers that can shift between remote teleoperation, autonomy and co-located human interaction. Our innovation consists of two components. The first component is a reconfigurable, dexterous manipulator that is designed to be mounted on a mobile robot. The manipulator will be light-weight and low-power. It will contain a reconfigurable number of up to seven degrees-of-freedom. The second component is a software system that can adjust control of the manipulator from teleoperated to autonomous and that can control the mobile robot and the manipulator as a coordinated unit. We propose to implement a method called Coordinated Resolved Motion Control that will automatically and jointly control the rover as well as the manipulator such that the manipulator will stay away from singularities. Together these two innovations will substantially increase the capabilities of NASA rovers, making them more efficient and effective.

Anticipated Benefits

Unmanned vehicles are becoming more and more common in battlefield situations. The Future Combat Systems (FCS) program envisions manned and unmanned vehicles of all sizes working side-by-side. In addition, Congress has mandated that one-third of all military vehicles must be unmanned by 2015. Explosive Ordnance Disposal (EOD) is the primary domain in which robots are currently used. No EOD robot on the market has a dexterous manipulator. We believe our reconfigurable technology will make us the clear choice in this market. Non-military markets such as civilian EOD, urban search and rescue and hostage situations are also increasingly using robots. Often a single mobile robot will have to perform many different tasks giving our reconfigurable technology an edge. Another market is the research robotics community such as universities and government laboratories. The reconfigurable aspect of our manipulator is a selling point because it allows laboratories to upgrade to more DOF over time and allows them to reconfigure the manipulator for different research objectives. We will also generalize our mobile robot interface to allow integration with commercially available robots. We expect that the next generation of robotics research will focus on mobile manipulation with programs being supported by NSF, NASA, DARPA and other funding agencies. NASA exploration missions will require significantly more complicated robots than are currently being used. Several NASA research projects, including Robonaut, K-10 and Athlete are working towards highly dexterous, intelligent robots. Our NASA applications will focus on our software as much as our hardware. While only a small number of dexterous

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Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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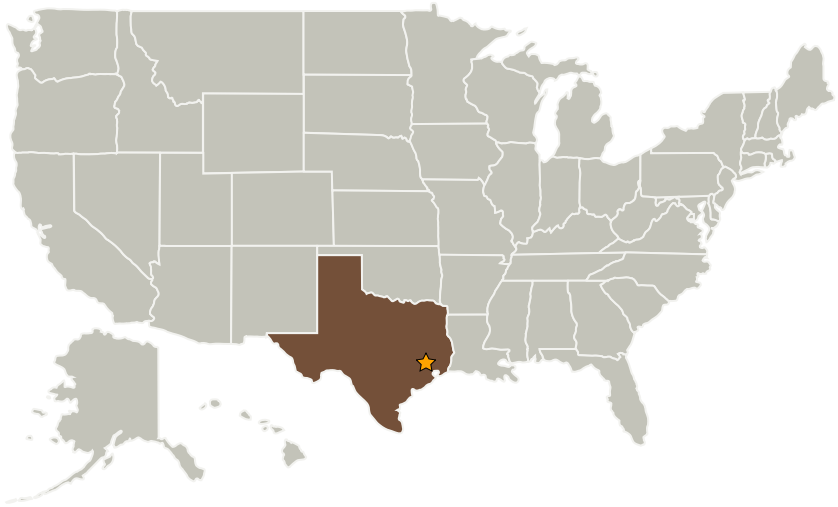
manipulators will be needed by NASA, many of NASA's research robots will require coordinated motion of rover and manipulation. For example, Centaur is a four-wheeled base with Robonaut on it being developed at NASA Johnson Space Center. NASA Ames Research Center (ARC) and the Jet Propulsion Laboratory also have research robots that combine mobility and manipulation. We will work with all of these researchers in Phase 3 to adapt our coordinated control software to their robots. In addition we expect to deliver our reconfigurable manipulator to NASA ARC for permanent mounting on one of their K-10 robots.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
TRACLabs, Inc.	Supporting Organization	Industry	Webster, Texas

Primary U.S. Work Locations
Texas

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Project Manager:
Darby F Magruder

Principal Investigator:
Robert Burridge

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.3 Manipulation
    - TX04.3.2 Grappling Technologies